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DISASSEMBLY OF TEST IRRADIATIONS AND FUEL ELEMENTS IN SMALL CAST IRON, ALPHA-GAMMA-CELLS AND THEIR SUBSEQUENT HANDLING

von

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P. J. Schmiddem, W. Stephan, K. Zamja

Abstract - Résumé

Three fairly small alpha-gamma cells, made from cast iron blocks, are being built for disassembling of test irradiations and fuel elements. Aside from disassembly equipment, the cells will enable the usual critical evaluation of the performance of the fueled section. The cells use gas-tight stainless steel boxes with double-cover alpha-gamma locks between boxes and to the outside. Special gas-tight, extended reach manipulators of a shortened design with a shielded through-wall plug are used. These manipulators are gas-tight and do not require plastic bootings for sealing to the boxes. Some equipment (periscope, dimensional measurement, gamma-scan) is of special design in order to save space in the narrow boxes.

DÉMONTAGE DES BOUCLES ET D' ELEMENTS COM-
BUSTIBLES, SOUMIS À DES ESSAIS D' IRRADIATION, DANS
DES CELLULES ALPHA-GAMMA EN FONTE, DE PETITES
DIMENSIONES. Trois cellules alpha-gamma de dimensions
relativement peu faibles, faites de blocs de fonte sont en
construction au Centre de Recherches Nucléaires (KFA) Jülich.
Les cellules seront utilisées pour démonter et examiner des
boucles irradiées dans le réacteur Dido afin d'éprouver divers
matériaux combustibles. Outre l' équipement de démontage, les

cellules comporteront les appareils nécessaires pour procéder à l'appréciation critique habituelle du comportement de la section contenant le combustible. Dans les cellules, on utilise des boîtes en acier inoxydable étanches au gaz; des sas alpha-gamma (double couvercles et plastique) font communiquer les boîtes entre elles et avec l'extérieur. Les manipulateurs sont étanches aux gaz et n'ont pas besoin des soufflets plastique pour procurer l'étanchéité des boîtes. Quelques outils (periscope, métrology, gamma scan) sont désignés spécialement pour gagner de place dans les boîtes.

I. INTRODUCTION

These cells were designed to be installed in an existing building (Fig. I.), and because of this, and our desire to maintain minimum costs, the cells are as small as possible. Since they are designed to use boxes and no power-manipulator is required, the resulting lower height makes them less expensive and easier to decontaminate. By using a shorter design of gas-tight, extended reach, heavy-duty master-slave-manipulator with shielding in the through-tubes, we were able to mount them at a lower height (2.40 m) and still obtain sufficient coverage. The length of the upper telescope section is 980 mm and each of the two other telescope sections moves 665 mm. By lowering the manipulator heights so that they penetrate the front-wall of the boxes, and utilizing the gas-tight design, we thus avoid plastic-box sealings. Fig. II. shows the method selected to insure the gas-tight connection to the box. The gas-tight seals for the manipulator are on the cold side of the cell-wall. When repair is needed we may either withdraw the entire manipulator into the operating gallery, or we may detach the slave-arm and remove it from the box through the rear opening. Instead of using the conventional in-cell crane or heavy-duty power manipulator for the handling of heavy weights, a small boom-crane (250 kg) mounted on the rear-wall of the box provides this function. (Fig. V.) The boom is articulated to give maximum coverage of the box. The cells are constructed of grey cast-iron in order to conserve the limited available space. The shielding value of the 46 cm thick walls is calculated for 4000 curies of a line-source (60 cm) of mixed fission products resulting from one year irradiation of reactor fuel to an integrated power of 40 kw, 28 days cooling-time. Each cell has a rear plug-door

to permit the installation of the table-mounted boxes. The boxes are made of stainless-steel. By the use of double-covers the boxes are connected to the transport-tunnel, storage-safe, other locks, and to each other, so that the box may be removed in an alpha-tight manner. The rear-wall of the box has a 1x1 m opening. The opening is closed with a plastic sheet in which are formed plastic gloves, a head-port, and a plastic-bagging port. This peculiar configuration allows a man to lean into the box with his arms, head and upper body to remove or repair equipment. For the removal of large equipment-items this elaborately-formed plastic cover is substituted by a normal plastic bag. During box operation the entire opening is closed by a solid cover.

All service connections, ventilation lines and cell lighting are conducted through removable plugs in the roof of the cells. This is done not only to conserve front wall-space but to make it easier to make and break connections to the boxes.

Transfer of wastes out of the cell is accomplished through locks which are provided with plastic bags and a welding device. The details of this process are given in ref. 3.

II. WORKING METHODS

A) Dismantling of loops and rigs

The first cell is used for the disassembly of loops and rigs. The irradiated assemblies are brought to the cells in a 30-ton horizontal transport cask carried upon a special truck. The truck provides vertical and horizontal adjustment in order to properly mate the cask to the lock. The approximately 3 m long loop is pushed through the lock into the box only far

enough for a simple hack-saw to cut off the end. Then the loop is pushed further into the cell to the point where the same saw removes the portion containing the experiment. (Fig. V.) The remaining, unwanted, portion of the loop is withdrawn back into the transport cask, the lock is closed, and the cask is removed from the building. The portion of the loop remaining in the cell may be further disassembled by simply pulling out the inner pieces, or it may be horizontally cut open by the slitting-saw illustrated in Fig. V. The large pieces of waste resulting from this disassembly process are then cut into smaller parts with the hack-saw, so that they may be canned and passed out through the waste-lock.

B) Optical examination, dimensional measurement, gamma-scan and collection of fission gases.

The fueled specimen is taken to the second cell via the transport-tunnel and is set in place on the multi-purpose test-stand. Since this specimen is 75 cm long, we made this test-stand to serve for optical examination, dimensional measurements, and gamma-scanning. The optical examination is carried out by passing the specimen under the objectives of a periscope which views the specimen from the side by means of a mirror (Fig. VI.) Surface measurement is made by reading the variations in induction of a coil actuated by the vertical movements of a cam-follower as the specimen is moved horizontally under it. Diameter is measured by the same system built into a caliper. Length-measurement is accomplished using the precision travel of the test-stand and stepping-motors whose movement is registered electrically outside the cell. Gamma-scanning is performed by using the test-stand to move the specimen before a collimator set into the cell wall.

The gamma-rays are passed through a hole in the mirror which is used in conjunction with the periscope. Detection and counting are essentially normal techniques. The test stand, of course, permits raising, lowering and rotating the specimen relative to the collimator. The next step in the examination is puncturing the fueled specimen container for the collection and analysis of fission-gases. The out-off-cell equipment for this process is located on the roof of the cell.

C) Sampling the fuel-material and packaging of waste.

The fueled specimen is returned to the first cell where small samples for metallography, physical measurements, radio-chemistry etc., are cut by a low-speed abrasive wheel. (Ref. 1,). This cut-off-device is a slightly modified commercial tool which allows both horizontal slitting and cross-section cut-off. Waste-fuel is canned in cold-welded aluminum-containers of up to 140 mm diameter. Wastes of lower activity are placed in food-cans or plastic containers. (Ref. 2).

D) Work in the third cell.

This cell is used for the examination of ball-shaped graphite-fuel-elements described in ref. 4.

E) Transfer of waste from the waste-cell.

This waste is transferred through a lock in the waste-cell into plastic bags which are welded closed in order to avoid the spread of contamination during the final packaging in shielded containers. Details of this process are found in ref. 3.

We gratefully acknowledge the help and cooperation of the firm Babcock & Wilcox, Oberhausen, who designed in detail and will deliver the cells and boxes.

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FIG. I : LABORATORY LAYOUT.

- LEGEND:
- | | |
|--|-----|
| 1. CASK LOCK | |
| 2. SERVICE AREA | |
| 3. HOT CELLS | |
| 4. OPERATING AREA | |
| 5. WASTE LOCK (LAB.-BZ I, LAB.- BZ II) | |
| 6. WASTE LOCK (LAB.-THTR) | |
| 7. THTR - HOT CELL PLANT | |
| 8. HYGIENE TRAKT (LAB. BZ I) | |
| 9. OPERATING AREA | " " |
| 10. SERVICE AREA | " " |
| 11. LEAD CELLS | " " |
| 12. FROGMEN SHOWER | |
| 13. HOT CHANGE ROOM | |
| 14. MENS COLD CHANGE ROOM | |
| 15. LADIES COLD CHANGE ROOM | |
| 16. W. C. MEN | |
| 17. REST ROOM | |
| 18. HEALTH PHYSICS | |
| 19. JANITORS CLOSET | |
- USED BY STAFF OF LAB. BZ - II
AND THTR HOT CELLS

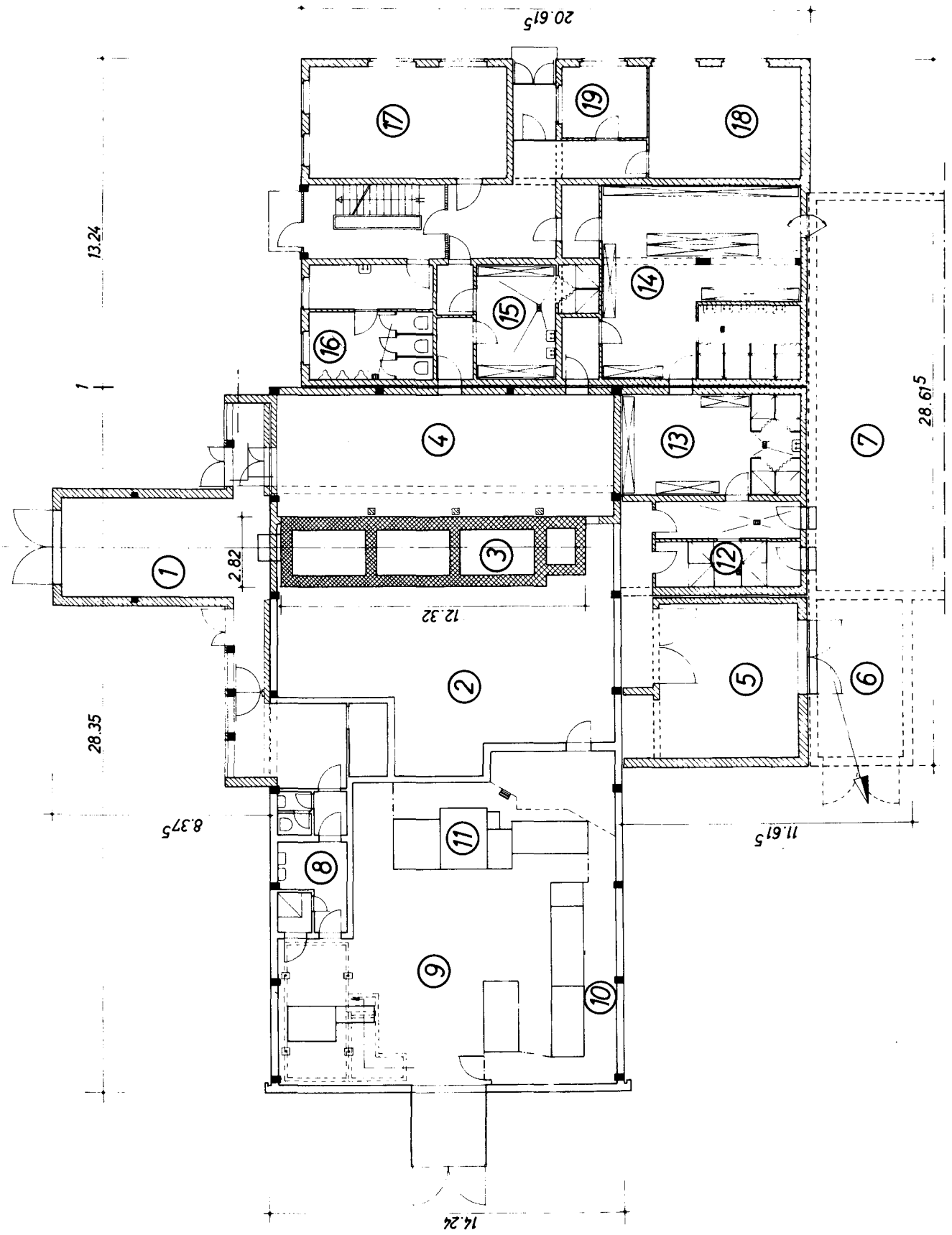


FIG. II: VERTICAL SECTION OF CELL AND BOX.

- LEGEND:
1. CAST IRON SHIELDING
 2. WINDOW
 3. MOVABLE BOX
 4. PLUG DOOR
 5. LOCK FOR SMALL SPECIMEN
 6. 10" LOCK
 7. TRANSPORT TUNNEL
 8. DOUBLE - COVER
 9. BOOM CRANE
 10. MANIPULATOR HWM A - 100/DGE
 11. VENTILATION DUCT

Babcockwerke
Oberhausen

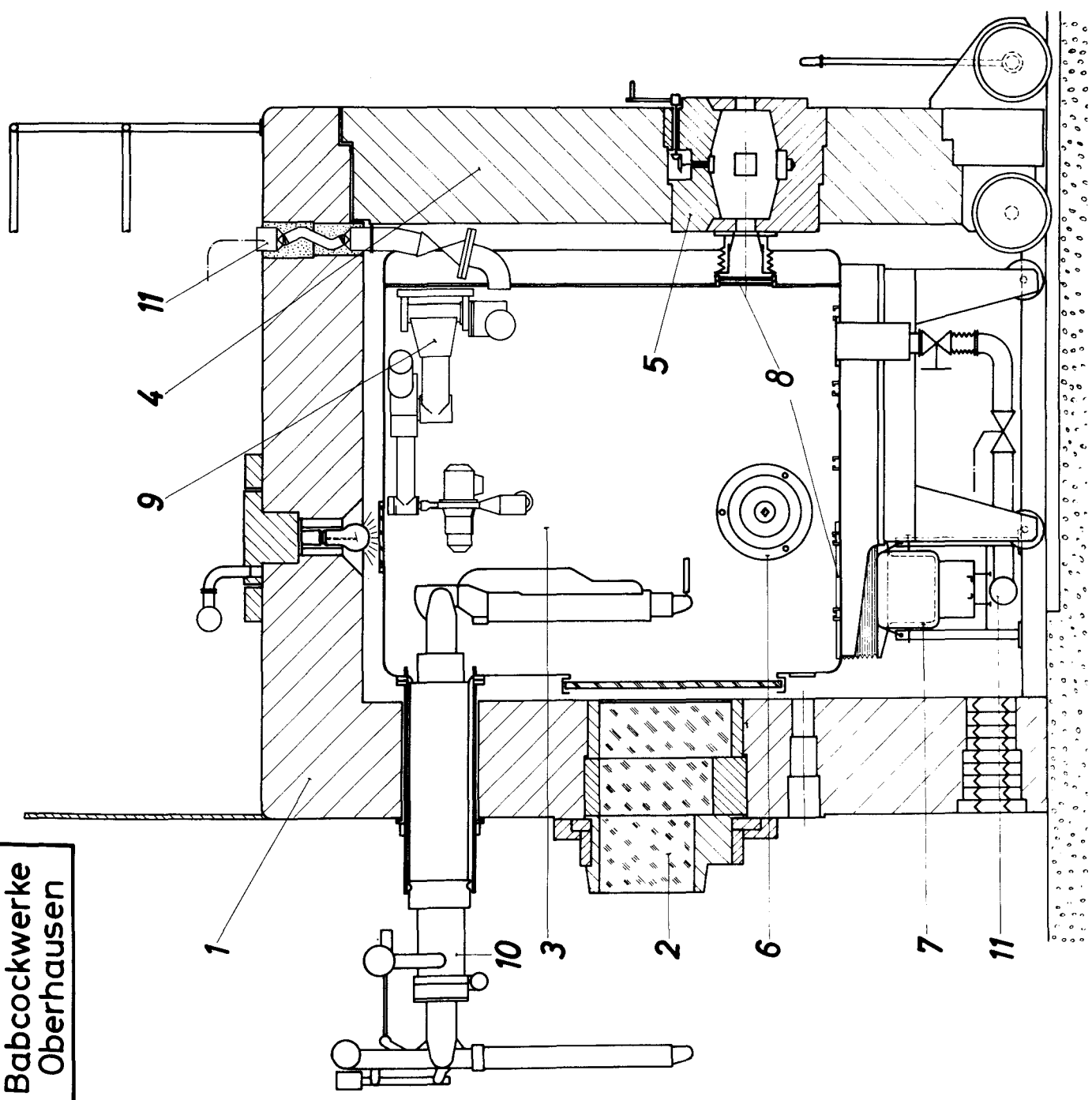
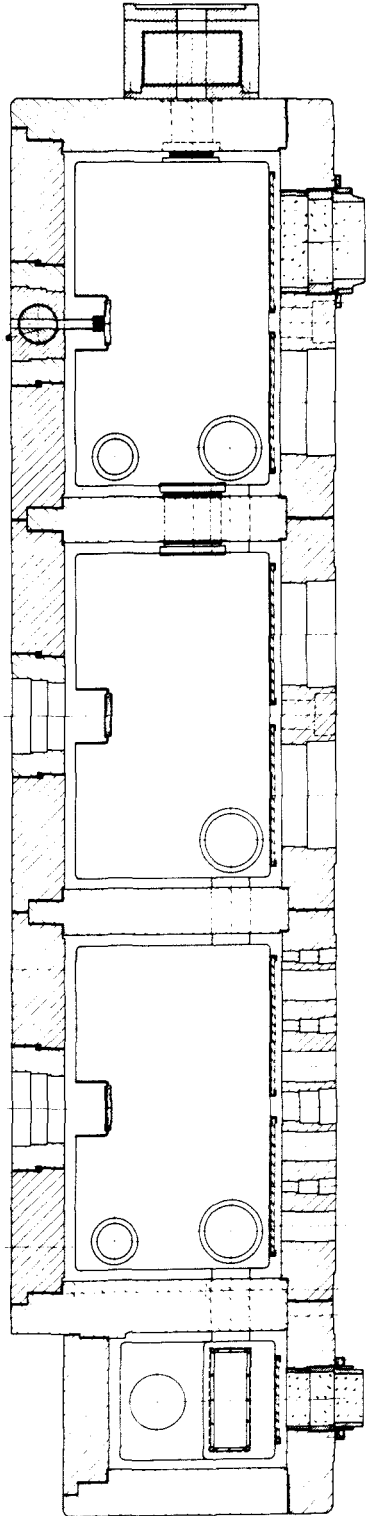
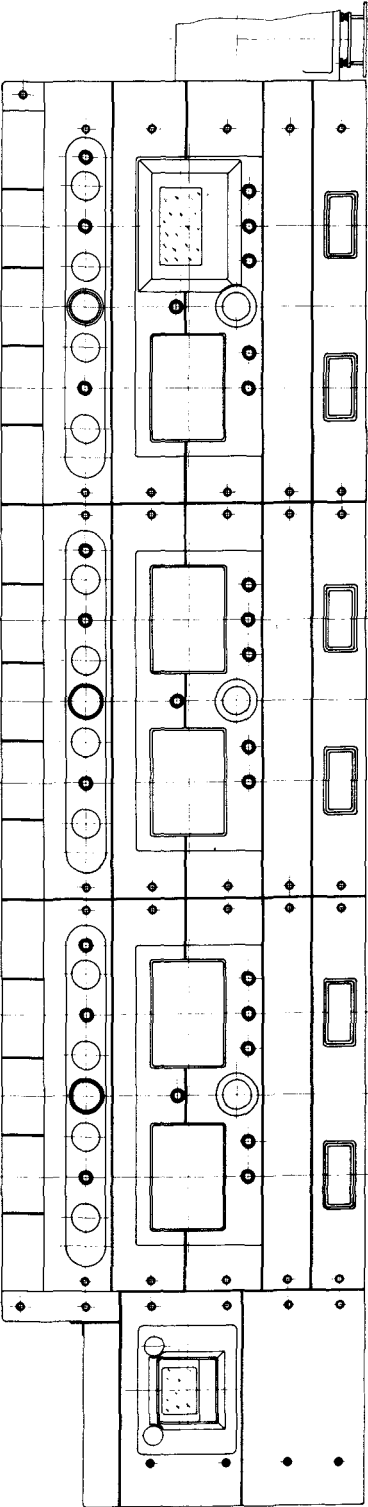
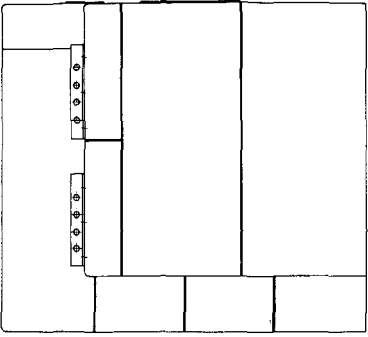


FIG. III : FRONT VIEW AND HORIZONTAL SECTION OF THE HOT CELLS.
THE HORIZONTAL SECTION ALSO SHOWING LOCKS, OUTLINES
OF THE BOXES, AND DOUBLE COVERS OF TRANSPORT TUNNEL
AND STORAGE CONTAINERS.



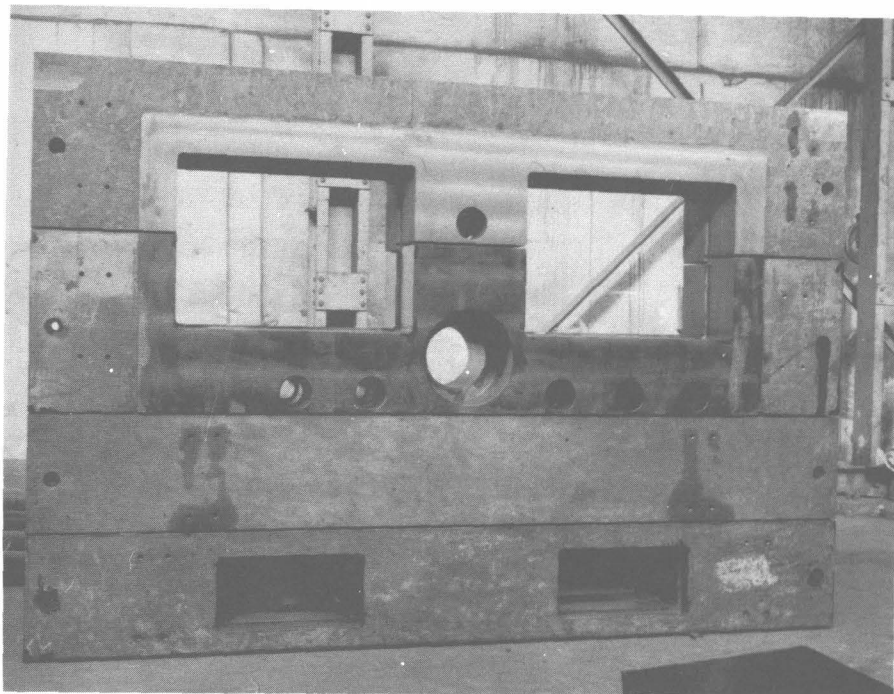


FIG. IV : PHOTOGRAPH SHOWING MOUNTING OF THE CAST IRON CELLS.
(BY COURTESY OF BABCOCK & WILCOX - GERMANY).

FIG. V : INTERIOR OF CELL NO. 1

- LEGEND:
1. HACK SAW
 2. SLITTING SAW
 3. SLOW SPEED CUT-OFF SAW
 4. BOOM CRANE
 5. FOOD CANNING MACHINE
 6. ULTRASONIC CLEANER
 7. COLD WELDING PRESS
 8. WASTE BOX

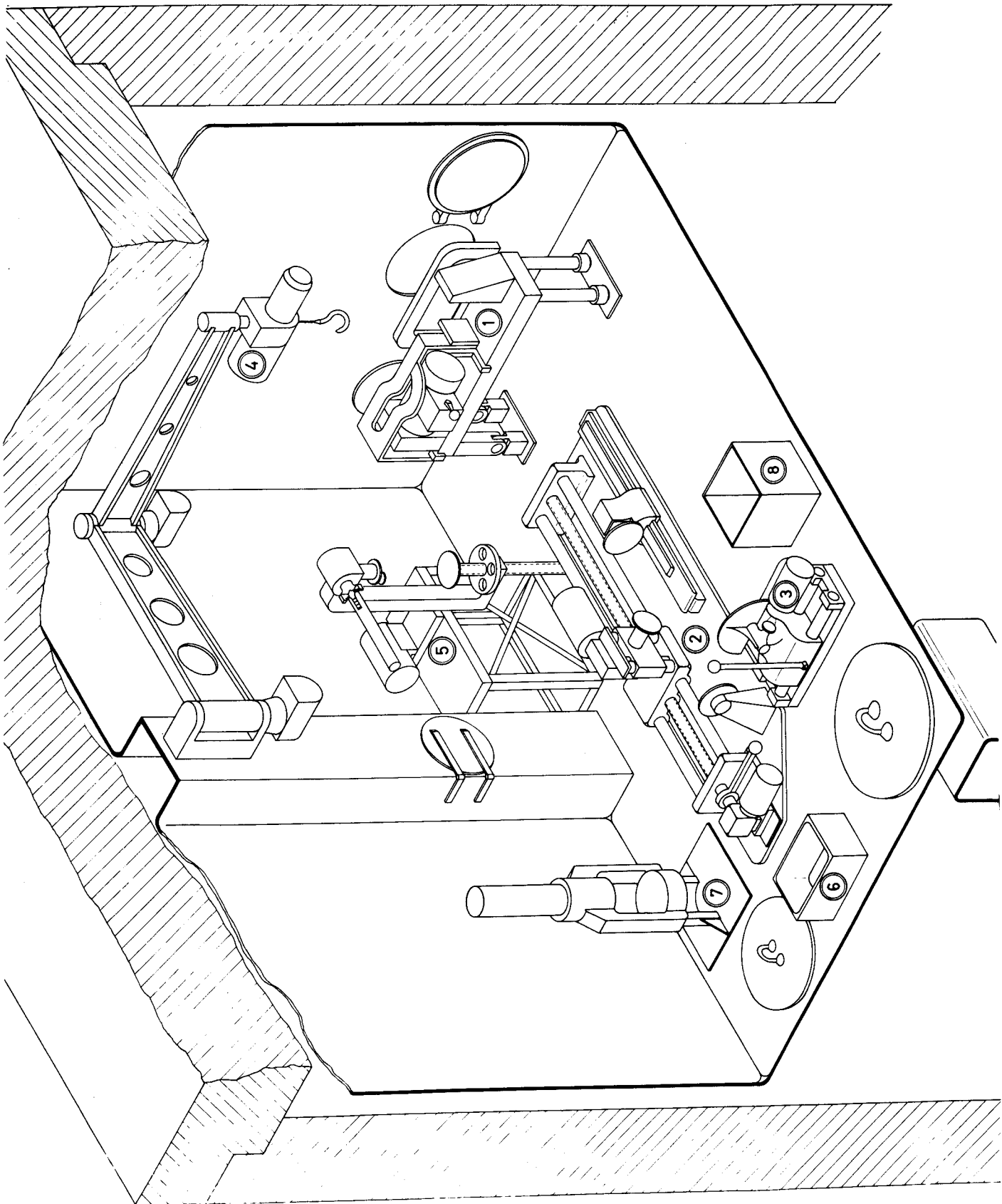


FIG. VI : INTERIOR OF CELL NO. 2

- LEGEND:
1. DIMENSIONAL MEASURING DEVICE
 2. COLLIMATOR
 3. STEREO-MICRO-PERISCOPE
 4. VAKUUM CHAMBER FOR FISSION GAS SAMPLING
 5. DRILL
 6. FUEL RODS PUNCTURING DEVICE
 7. MANIPULATOR
 8. DOUBLE-COVER OF TUNNEL OPENING
 9. TRANSPORT TUNNEL

